

CLAIMS

[1] A howling suppression device for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression device comprising:

a first power spectrum information producing section for producing a first power spectrum according to a first acoustic signal output from the first microphone collecting a sound;

second acoustic signal obtaining means for obtaining a second acoustic signal of a sound including at least the intensified sound and not including the target sound;

a second power spectrum information producing section for producing a second power spectrum according to the second acoustic signal; and

a suppression filter section for filtering the first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

[2] The howling suppression device according to claim 1, wherein the second acoustic signal obtaining means is a second microphone provided in a sound field in which the first microphone and the loudspeaker are provided, the second microphone not collecting the target sound while collecting at least the

intensified sound in the sound field to output the second acoustic signal.

[3] The howling suppression device according to claim 1, wherein the second acoustic signal obtaining means is realized by connecting a line between the amplification section and the loudspeaker with the second power spectrum information producing section so that a signal output from the amplification section is output to the second power spectrum information producing section as the second acoustic signal.

[4] The howling suppression device according to claim 1, further comprising:

a signal-to-signal delay detecting section for detecting a delay time between the first acoustic signal output from the first microphone and the second acoustic signal; and

a signal delaying section for inputting the second acoustic signal to the second power spectrum information producing section after delaying the second acoustic signal according to the delay time detected by the signal-to-signal delay detecting section.

[5] The howling suppression device according to claim 1, further comprising:

a learning control section for, based on the first acoustic signal and the second acoustic signal, detecting a period in which the first microphone is not collecting the target sound and the second acoustic signal is indicating the intensified sound or a

reverberating sound of the intensified sound, and for outputting a control signal indicating the period;

a ratio storing section for storing a ratio of the second power spectrum with respect to the first power spectrum; and

5 a spectrum ratio estimating section for calculating the ratio of the second power spectrum with respect to the first power spectrum when the control signal is indicating the period, and updating the stored ratio in the ratio storing section by a predetermined method using the calculated ratio,

10 wherein the suppression filter section estimates a sound component other than the target sound, which has been mixed in the first acoustic signal, by using the first power spectrum, the second power spectrum and the ratio stored in the ratio storing section and suppresses the sound component in the first acoustic
15 signal to thereby output only an acoustic signal of the target sound to the amplification section.

[6] The howling suppression device according to claim 5, wherein:

the learning control section outputs a control signal
20 indicating the period by a ratio of a signal level of the second acoustic signal with respect to a signal level of the first acoustic signal; and

the spectrum ratio estimating section calculates the ratio of the second power spectrum with respect to the first power
25 spectrum when the signal level ratio indicated by the control signal

is greater than or equal to a threshold value.

[7] The howling suppression device according to claim 1, wherein the suppression filter section filters the first acoustic signal by a Wiener filter method based on the first power spectrum and the second power spectrum so as to output only an acoustic signal of the target sound to the amplification section.

[8] The howling suppression device according to claim 1, wherein the suppression filter section filters the first acoustic signal by a spectral subtraction method based on the first power spectrum and the second power spectrum so as to output only an acoustic signal of the target sound to the amplification section.

[9] A howling suppression program executed by a computer for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression program instructing the computer to perform:

a first power spectrum information producing step of producing a first power spectrum according to a first acoustic signal output from the first microphone collecting a sound;

a second acoustic signal obtaining step of obtaining a second acoustic signal of a sound including at least the intensified sound and not including the target sound;

a second power spectrum information producing step of producing a second power spectrum according to the second acoustic

signal; and

a suppression step of filtering the first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

[10] An integrated circuit for suppressing howling, which occurs when amplifying a target sound collected by a first microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the integrated circuit comprising:

a first power spectrum information producing section for receiving a first acoustic signal output from the first microphone collecting a sound, and producing a first power spectrum according to the first acoustic signal;

a second power spectrum information producing section for receiving a second acoustic signal of a sound including at least the intensified sound and not including the target sound, and producing a second power spectrum according to the second acoustic signal; and

a suppression filter section for filtering the received first acoustic signal based on the first power spectrum and the second power spectrum to output only an acoustic signal of the target sound to the amplification section.

[11] A howling suppression method for suppressing howling, which occurs when amplifying a target sound collected by a first

microphone through an amplification section and outputting the amplified sound as an intensified sound from a loudspeaker, the howling suppression method comprising:

5 a first power spectrum information producing step of producing a first power spectrum according to a first acoustic signal output from the first microphone collecting a sound;

 a second acoustic signal obtaining step of obtaining a second acoustic signal of a sound including at least the intensified sound and not including the target sound;

10 second power spectrum information producing step of producing a second power spectrum according to the second acoustic signal; and

 a suppression step of filtering the first acoustic signal based on the first power spectrum and the second power spectrum
15 to output only an acoustic signal of the target sound to the amplification section.